

112740-205

09/831179

INTERNATIONAL APPLICATION NO.
PCT/DE99/03484INTERNATIONAL FILING DATE
02 November 1999

TITLE OF INVENTION

MOBILE STATION, BASE STATION AND METHOD FOR DATA TRANSMISSION IN A MOBILE RADIO SYSTEM

APPLICANT(S) FOR DO/EO/US

Bernhard Raaf

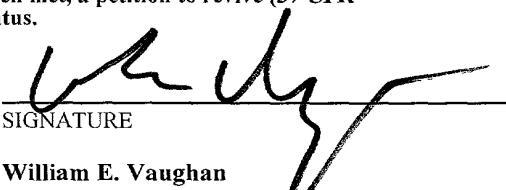
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. has been transmitted by the International Bureau.
 - c. is not required, as the application was filed in the United States Receiving Office (RO/US).
6. A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. A copy of the International Search Report (PCT/ISA/210).
8. Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. have been transmitted by the International Bureau.
 - c. have not been made; however, the time limit for making such amendments has NOT expired.
 - d. have not been made and will not be made.
9. A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. A **FIRST** preliminary amendment.
16. A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. A substitute specification.
18. A change of power of attorney and/or address letter.
19. Certificate of Mailing by Express Mail
20. Other items or information:

Submission of Drawings Figures 1-3 on two sheets

U.S. APPLICATION NO. (IF KNOWN SEE 37 CFR 09/831179	INTERNATIONAL APPLICATION NO. PCT/DE99/03484	ATTORNEY'S DOCKET NUMBER 112740-205																				
21. The following fees are submitted:		CALCULATIONS PTO USE ONLY																				
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :																						
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<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">CLAIMS</th> <th style="width: 25%;">NUMBER FILED</th> <th style="width: 25%;">NUMBER EXTRA</th> <th style="width: 25%;">RATE</th> </tr> </thead> <tbody> <tr> <td>Total claims</td> <td>17 - 20 =</td> <td>0</td> <td>x \$18.00</td> </tr> <tr> <td>Independent claims</td> <td>3 - 3 =</td> <td>0</td> <td>x \$80.00</td> </tr> <tr> <td colspan="2">Multiple Dependent Claims (check if applicable).</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">\$0.00</td> </tr> <tr> <td colspan="2" style="text-align: center;">TOTAL OF ABOVE CALCULATIONS</td> <td style="text-align: center;">\$860.00</td> <td></td> </tr> </tbody> </table>		CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	Total claims	17 - 20 =	0	x \$18.00	Independent claims	3 - 3 =	0	x \$80.00	Multiple Dependent Claims (check if applicable).		<input type="checkbox"/>	\$0.00	TOTAL OF ABOVE CALCULATIONS		\$860.00		
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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.																						
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 SIGNATURE William E. Vaughan NAME 39,056 REGISTRATION NUMBER May 4, 2001 DATE																						

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JC08 Rec'd PCT/PTO 04 MAY 2001

Docket No.

112740-205

CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)

Applicant(s): Bernhard Raaf

Serial No.

Filing Date

Examiner

Group Art Unit

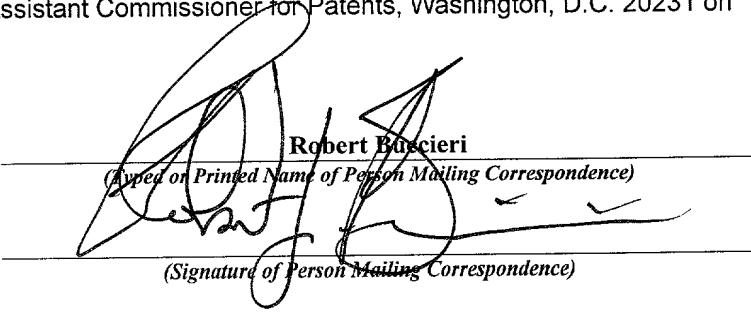
Invention: MOBILE STATION, BASE STATION AND METHOD FOR DATA TRANSMISSION IN A MOBILE RADIO SYSTEM

I hereby certify that the following correspondence:

Transmittal Letter to the United States Designated/Elected Office in duplicate, international application as filed, amended pages, English translation, amended pages, IDS, PTO 1449, references, search report, Preliminary Amendment, Submission of Drawings Figures 1-3 on two sheets, filing fee \$860.00, postcard (see attached envelope for executed assignment and fee)

(Identify type of correspondence)

is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to: The Assistant Commissioner for Patents, Washington, D.C. 20231 on

May 4, 2001*(Date)*
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IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT: Bernhard Raaf DOCKET NO: 112740-205

SERIAL NO: GROUP ART UNIT:

EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE99/03484

INTERNATIONAL FILING DATE: 02 November 1999

INVENTION: MOBILE STATION, BASE STATION AND METHOD FOR
DATA TRANSMISSION IN A MOBILE RADIO SYSTEM

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry
into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C.
§371 as follows:

In the Specification:

Please replace the Specification of the present application, including the
Abstract, with the following Substitute Specification:

S P E C I F I C A T I O N

TITLE

**MOBILE STATION, BASE STATION AND METHOD FOR DATA
TRANSMISSION IN A MOBILE RADIO SYSTEM**

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a base station, a mobile station and a
method for data transmission in a communication system, in particular in a CDMA
mobile radio system, where the data, structured in frames, is transmitted such that a
mobile station is able to perform other functions; in particular, to carry out tests
using a reception device, during one or more interruption phases in which it
interrupts the reception (of the previous source or of the data from the base station)

and/or the processing of received data or sending. "Transmission" is to be understood as sending and/or receiving below.

Description of the Prior Art

In communication systems, data (for example voice data, image data or system data) is transmitted on transmission links between base stations and mobile stations. In radio communication systems, this is done using electromagnetic waves via an air or radio interface. In this context, carrier frequencies are used which are situated in the frequency band provided for the respective system. In the case of the GSM (Global System for Mobile Communication), the carrier frequencies are in the range of 900 MHz. For future radio communication systems, for example the UMTS (Universal Mobile Telecommunication System) or other third generation systems, frequencies in the frequency band of 2000 MHz are provided.

Particularly in future CDMA systems, a base station basically sends continuously in the downlink direction, for example, that is to say in the direction from the base station to a mobile station. The data transmitted during sending is usually structured in frames which each have a prescribed length. Particularly with different services such as voice data transmission and video data transmission, the frames may also have different structures and lengths. The structure and/or length of each frame in a continuous series of frames is prescribed and/or is recognized by the mobile station, however.

Particularly in cellular mobile radio systems, the mobile station occasionally also needs to perform functions other than data reception which cannot be performed at the same time, at least during the operation of only a single reception device. By way of example, from time to time the mobile station in a radio communication system of cellular design in which the base stations in various cells send on different frequencies needs to test whether it is able to receive radio signals from another base station with good reception quality. For this purpose, the mobile station sets its reception device to a frequency other than the frequency on which it currently receives data.

In order to be able to send from the base station to the mobile station without interruption, it has already been proposed that the mobile station be

equipped with a second reception device. In practice, however, this solution is usually rejected for cost reasons.

Another proposal is known according to which the base station interrupts sending at prescribed times in order to allow the receiving station to carry out an adjacent channel search (search for an adjacent base station or for particular data packets transmitted by these base stations, where data packets also may be understood below to be synchronization, frequency correction or pilot signal bursts) using its individual reception device.

To prevent a loss of data, the base station sends the data beforehand at a higher transmission rate than the fundamentally constant permanent transmission rate. So that this does not result in higher bit error rates (BER), the transmission power additionally needs to be increased during this time.

The frequency at which the interruption phases recur and the length of the interruption phases depend on the particular system and also on the particular operating state of the system. By way of example, interruption phases each having a length of 5 to 6 ms, respectively, are sufficient for an adjacent channel search by a mobile station in a radio communication system organized on a cellular basis. WO-A-97 25827 discloses a method for data transmission, in which interruption phases for observing an adjacent base station are inserted during transmission. However, provision is made in this case for the interruption phases to be inserted at regular intervals, which entails the disadvantage that the efficiency of the data transmission is reduced with each interruption phase.

Since the losses in transmission quality also increase with the number of interruption phases inserted, it is desirable for the smallest possible number of interruption phases to be inserted.

By way of example, a GSM frame transmitted by the GSM base station contains eight timeslots which each contain a data packet. The data packets transmitted by the GSM base station BS2, such as synchronization data packets (data packets to be detected, synchronization burst), frequency correction data packets (characteristic data packets, frequency correction burst) and normal data packets, are all subordinate to the same time frame. The GSM base stations transmit all 10 time frames (GSM frames) 4 times and, after a subsequent 11 time

frames (GSM frames) (51 time frames in total), a frequency correction data packet, and one respective time frame later, a synchronization data packet.

If interruption phases based on the GSM standard were now inserted with a period of 26 time frames (GSM frames), the fact that the period of 51 time frames and the period of 26 time frames have no common denominator would cause a cyclic shift in the two time frame periods, so that after a maximum of 11 times 26 time frames, that is to say after 11 observation frames, the sought data packet which is to be detected would be received if the mobile station is not too distant from the respective adjacent base station BS2, BS3 or if no interference which is too intense arises during transmission.

It is an object of the present invention, therefore, to specify a method for data transmission, a mobile station and a base station which permit second base stations to be reliably observed while transmission quality is good.

SUMMARY OF THE INVENTION

Accordingly, the present invention is based, in particular, on the concept of, contrary to the prior art, inserting interruption phases in which the mobile station interrupts the transmission, in particular the reception, of the data sent by the first base station and/or the processing of the received data not with a maximum effective total duration which would be needed under optimum transmission conditions for secure detection of a data packet which is to be detected, but instead inserting fewer and/or shorter interruption phases.

Complex simulations using simulation tools developed specially for this purpose have proved that, when the effective total duration of the interruption phases is shortened, contrary to the prior art, to a duration of a maximum of 9 or a maximum of 10 observation frames, the effective total duration of the interruption phases can be reduced by a much greater proportion than, in return, the theoretical detection probability for a data packet which is to be detected decreases. The effect of this is that the transmission quality from the first base station to a mobile station is improved, but in return the detection probability for a data packet which is to be detected remains comparatively high with respect thereto.

In this case, the data can be sent, by way of example, from the first base station to the mobile station, in which case, at least during particular transmission

phases, interruption phases are inserted in which the first base station interrupts sending, and the mobile station interrupts the reception and/or the processing of received data, for example. In addition, the mobile station is switched to the reception of the characteristic data packets and/or data packets which are to be detected, which are sent cyclically by a second base station, and the maximum effective total duration of the interruption phases is shorter than would be needed under optimum transmission conditions for secure detection of a data packet which is to be detected.

The data packets sent by the second base station also may be data packets which are to be detected (synchronization data packets) or characteristic data packets (frequency correction data packets).

In this context, a first transmission method, used by a first base station, may be a CDMA method, and a second transmission method, used by a second base station, may be a GSM method.

Within the context of the application, GSM frame is also understood to be a frame which contains 8 time slots and has a duration of 4.6 ms.

Within the context of the application, observation frame is also understood to be a minimum time period required in order to observe a GSM frame. In this case, the exact duration of an observation frame is implementation-dependent; however, in order to ensure full detection of a GSM frame and to allow for the time needed for changing over the synthesizer frequency, it is generally longer than the duration of a GSM frame and may thus also have a duration of 9 time slots, 10 time slots (5.7 ms), 11 time slots or 12 time slots (6.9 ms).

Since many different variants are possible for inserting the interruption phases for the purpose of the adjacent channel search, the term “maximum effective total duration of the interruption phases” within the context of this application denotes the sum of all the interruption phases inserted as a maximum in order to observe an adjacent base station. However, this does not preclude further interruption phases from being inserted during subsequent repetition of the adjacent channel search, although a new effective total duration of the interruption phases is formed in this case. Under these circumstances, the individual interruption phases each may have the duration of an observation frame, but also

may have any other duration. The duration of an interruption phase also may have a multiple or a fraction of the duration of an observation frame. It is also possible for the individual interruption phases to have different durations.

In one embodiment of the present invention, a period of 52 GSM frames lies between the start of a first interruption phase and the start of a second interruption phase.

Simulations have been able to show that this allows the effective total duration of the interruption phases to be reduced to 91%, with a mere loss of 2% needing to be accepted for the detection probability in return, as well as a halving of the search speed in comparison with the GSM search speed.

In another embodiment of the present invention, a period of 6 GSM frames is inserted between the start of a first interruption phase and the start of a first interruption phase and the start of a second interruption phase, and a period of 46 GSM frames is inserted between the start of a second interruption phase and the start of a third interruption phase.

In this case, simulations have been able to show that, at GSM search speed, the maximum effective total duration of the interruption phases can be reduced by 9% for a comparatively very small detection possibility loss of 2%.

In another embodiment of the present invention, the insertion of further interruption phases is ended, restricted or continued under control before the maximum effective total duration of the interruption phases is actually reached. To this end, after reception of a data packet which is to be detected or possibly of another data packet, indicating the end of the adjacent channel search, such as a characteristic data packet, an appropriate message is transmitted from the mobile station to the first base station.

Thus, while data is transmitted from a first base station to a mobile station in the downlink direction, for example, interruption phases are inserted, at least during particular send phases, in which the mobile station interrupts the reception of the data sent by the first base station and/or the processing of the received data and in which the mobile station is switched to the reception of data packets sent by a second base station. Depending on a reception result for these data packets sent

by a second base station, information which influences the insertion of interruption phases is sent from the mobile station to the first base station.

In this way, it is possible for the insertion of interruption phases to be ended as soon as possible, and hence to be restricted as far as possible, as soon as sufficient information is known about the second base stations which are to be observed, and hence for the transmission quality to be improved. The effect of this is that the total duration of the interruption phases can be reduced further.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a basic circuit diagram of a mobile radio system;

Figure 2 shows a basic circuit diagram of a mobile station; and

Figure 3 shows a schematic illustration of the insertion of interruption phases during a send phase.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a cellular mobile radio network including, by way of example, a combination of a GSM (Global System for Mobile Communication) system with a UMTS (Universal Mobile Telecommunication System) system, which includes a multiplicity of mobile switching centers MSC which are interlinked and set up access to a landline network PSTN/ISDN. In addition, these mobile switching centers MSC are connected to at least one respective base station controller BSC, which also may be formed by a data processing system.

Each base station controller BSC is, in turn, connected to at least one base station BS. Such a base station BS is a radio station which is able to use a radio interface to set up a radio link to other radio stations, so-called mobile stations MS. Radio signals can be used to transmit information between the mobile stations MS and the base station BS associated with these mobile stations MS within radio channels situated within frequency bands. The range of the radio signals of a base station defines, in essence, a radio cell FZ.

Base stations BS and a base station controller BSC can be combined to form a base station system. In this context, the base station system BSS is also

responsible for radio channel administration and allocation, data rate matching, monitoring of the radio transmission link, handover procedures and, in the case of a CDMA system, for the allocation of the spread code sets which are to be used, and transmits the signaling information required for this to the mobile stations MS.

In the case of a duplex system, the frequency bands provided for the uplink (mobile station to base station) may be different than those provided for the downlink (base station to mobile station) in FDD (Frequency Division Duplex) systems such as the GSM system, and, in TDD (Time Division Duplex) systems, such as the DECT (Digital Enhanced Cordless Telecommunications) system, different time intervals may be provided for the uplink and for the downlink. Within the different frequency bands, an FDMA (Frequency Division Multiple Access) method can implement a number of frequency channels.

Terms and examples used within the context of this application also often refer to a GSM mobile radio system; they are in no way limited thereto, however, but rather also may be easily mapped onto other, possibly future, mobile radio systems, such as CDMA systems, in particular wideband CDMA systems or TD/CDMA systems, by a person skilled in the art using the description. First base station BS1 is understood to be, in particular, a UMTS base station or a CDMA base station, second and/or third base stations BS2, BS3 are understood, in particular, to be GSM (adjacent) base stations which are to be observed, and mobile station is understood, in particular, to be a dual mode mobile station designed both for receiving/sending GSM signals and for receiving/sending UMTS signals or CDMA signals, the dual mode mobile station also being able to be made ready for stationary operation, if appropriate.

Figure 2 shows a radio station which may be a mobile station MS, including an operating unit MMI, a control device STE, a processing device VE, a power supply device SVE, a reception device EE and a transmission device SE.

The control device STE in essence includes a program controlled microcontroller MC which has write and read access to memory modules SPE. The microcontroller MC controls and supervises all the fundamental elements and functions of the radio station, in essence controls the communication and signaling

flow, reacts to keypad inputs by executing the corresponding control procedures and is also responsible for transferring the appliance into different operating states.

The processing device VE also can be formed by a digital signal processor DSP which is likewise able to access memory modules SPE.

The volatile or nonvolatile memory modules SPE store the program data required for controlling the radio station and the communication flow, and also the signaling procedures in particular, appliance information, information entered by the user and information arising during the processing of signals.

The radio frequency part HF includes the transmission device SE, having a modulator and an amplifier, and a reception device EE having a demodulator and likewise an amplifier.

The transmission device SE and the reception device EE are supplied with the frequency of a voltage controlled oscillator VCO using the synthesizer SYN. The voltage controlled oscillator VCO also can be used to generate the system clock for clocking processor devices of the appliance.

For receiving and sending signals via the air interface of a mobile radio system, an antenna device ANT is provided.

The radio station also may be a base station BS. In this case, the operating unit is replaced by a link to a mobile radio network, for example via a base station controller BSC or a switching center MSC. In order to interchange data with a number of mobile stations MS at the same time, the base station BS has an appropriate multiplicity of transmission and reception devices available.

Figure 3 shows the frame structure of a data transmission with a short delay time, in particular of voice transmission in a UMTS (Universal Mobile Telecommunication System), containing twelve individual frames 1 for data transmission within a respective multiframe. In this case, the illustration shows, in particular, a send phase in the downlink from a first base station BS1, in particular a UMTS base station BS1, to a mobile station MS, in particular a dual mode mobile station MS, designed not only for receiving UMTS data but also for receiving GSM data packets. The statements employed below are, in essence, restricted to the downlink. It goes without saying, however, that the present invention can be introduced not only to downlink transmission, but also to uplink

transmission. It is within the scope of action of a person skilled in the art to introduce the exemplary embodiments demonstrated below for the downlink to uplink transmission.

The individual frames 1 each have a transmission length T_f of 10 ms, wherein the multiframe has a transmission length T_s of 120 ms in total. The respective fifth and sixth individual frames 1 have a common interruption phase 2 (possibly overlapping their frame boundaries 3) which has a length T_i . The length T_i is 6 ms, for example. The subsections of the first frame 4a, which starts before the interruption phase 2, and of the second frame 4b, which ends after the interruption phase 2, are of the same length or of the same size. In the case of the exemplary embodiment shown in Figure 3, voice data is being transmitted, so that a maximum delay of 10 ms, that is to say a frame length T_f , when evaluating the data received by the mobile station is acceptable. The data within a frame is sorted, coded together and sent superimposed on one another. In the exemplary embodiment, the transmission rate of the first frame 4a and of the second frame 4b is increased, in each case, such that the same quantity of information which is to be sent, which is sent in uncompressed frames 1 over the frame length T_f , is sent in a time span $T_c = T_f - T_i/2$.

In this case, during the interruption phases, at least the sending of data to a particular mobile station carrying out the adjacent channel search is interrupted, while sending to other mobile stations can be continued, this being made possible by the use of a multiple access method, for example a CDMA method.

A GSM frame transmitted by the GSM base station contains eight timeslots which each contain a data packet. The data packets transmitted by the GSM base station BS2, such as synchronization data packets (data packets to be detected, synchronization burst), frequency correction data packets (characteristic data packets, frequency correction burst) and normal data packets, are all subordinate to the same time frame. The GSM base stations transmit all 10 time frames (GSM frames) 4 times and, after a subsequent 11 time frames (GSM frames) (51 time frames in total), a frequency correction data packet, and one respective time frame later, a synchronization data packet.

If interruption phases based on the GSM standard were now inserted with a period of 26 time frames (GSM frames), the fact that the period of 51 time frames and the period of 26 time frames have no common denominator would cause a cyclic shift in the two time frame periods, so that after a maximum of 11 times 26 time frames, that is to say after 11 observation frames, the sought data packet which is to be detected would be received if the mobile station is not too distant from the respective adjacent base station BS2, BS3 or if no interference which is too intense arises during transmission.

If the maximum effective total duration of the interruption phases is now reduced, contrary to the prior art, from 11 observation frames to, by way of example, 10 or 9 observation frames when observing GSM base stations during the call phase for a mobile station MS and a UMTS base station BS1, the data transmission within the context of the call by the mobile station MS via the base station BS1 can be improved. The associated reduction in detection probability is comparatively small and is thus acceptable.

In one variant embodiment of the present invention, data packets which are to be detected are transmitted by a second base station BS2 within GSM frames, and interruption phases for adjacent channel observation are inserted into the downlink data transmission from a UMTS base station BS1 to a mobile station MS, with a period of 52 GSM frames lying between the start of a first interruption phase and a second interruption phase.

In another variant embodiment, a period of 26 GSM frames lies between the start of a first interruption phase and a second interruption phase.

In another embodiment of the present invention, a period of n_1 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of n_2 GSM frames lies between the start of a second interruption phase and a third interruption phase.

In another embodiment of the present invention, a period of 6 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of 46 GSM frames lies between the start of a second interruption phase and a third interruption phase.

In another embodiment of the present invention, a period of 16 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of 36 GSM frames lies between the start of a second interruption phase and a third interruption phase.

By way of example, while the mobile station MS is in the call condition or user data transmission condition with a current UMTS base station BS1, the interruption phases are inserted at particular points in time/intervals of time, between which there may be time spans of fixed or different length, into the downlink transmission, during which the reception device of the mobile station MS is switched to the reception of data packets from respective adjacent GSM base stations BS2, BS3. During the interruption phase 2, the UMTS base station thus interrupts the sending of data to the mobile station MS, and the mobile station MS interrupts the reception and/or the processing of data sent by the UMTS base station BS1. The mobile station MS uses the reception device EE to carry out an adjacent channel search by virtue of the control device STE switching the reception device EE to the reception of adjacent GSM base stations BS2 and of the data packets sent thereby, in order to receive any synchronization data packets dp which arrive, sent by adjacent GSM base stations BS2, BS3.

The aim of the adjacent channel search is also to detect a synchronization data packet which is to be detected. In one embodiment of the present invention, if, in one of these interruption phases, the mobile station MS receives a synchronization data packet which is to be detected, then the adjacent channel search has ended, at least for this base station BS2, and the mobile station MS sends appropriate control information m (SCH-found) to the first base station BS1, the UMTS base station, possibly via suitable signaling channels. The UMTS base station BS1 then inserts no further interruption phases into the downlink data stream d, at least at first. In this case, the effective total duration of the interruption phases is generally shorter than the maximum effective total duration of the interruption phases.

A synchronization data packet which is to be detected also can be detected using the reception of a characteristic frequency correction data packet, since the known frame structure after reception of a frequency correction data packet results

in the position of a synchronization data packet to be known. Since, in the GSM system, the base stations BS2, BS3 transmit the frequency correction data packets one time frame before the synchronization data packets, in one embodiment of the present invention, the mobile station MS is able not only to receive synchronization data packets but also to be switched to the reception of frequency correction data packets. In this case, the mobile station MS carries out an adjacent channel search in the interruption phases using the reception device EE, by virtue of the control device STE switching the reception device EE to the reception of adjacent GSM base stations BS2, in order to receive any synchronization data packets and frequency correction data packets which arrive, sent by adjacent GSM base stations BS2, BS3.

Within the context of this application, the concept of “the mobile station being switched to the reception of data packets which are to be detected and/or characteristic data packets” is also understood as, after the customary analog and digital filtering, and possibly derotation, the received data packet being compared (e.g., correlated) with the correlation series corresponding to the training sequence of a characteristic data packet dp and/or with the correlation series corresponding to the training sequence of a data packet dp which is to be detected, and hence data packets which are to be detected and characteristic data packets are sought at the same time or in parallel. Instead of correlation, other methods also may be used if appropriate (e.g., FIR, IRR or other filters). If a data packet is received or detected with sufficient quality, or the information transported using the data packet is ascertained with sufficient quality, etc., the reception result for this data packet can be said to be positive.

In one embodiment, the mobile station MS is now able, after reception of a frequency correction data packet, to send information m to the UMTS base station BS1 (FCCH-found), which information now causes just one further interruption phase to be inserted into the sent data stream at first, in order to receive the synchronization data packet following the frequency correction data packet at a fixed distance. The knowledge about the relative positions in time of the frequency correction data packet and the synchronization data packet allows the position in time and also the duration (since the timeslot is now known) of the interruption

phase which is to be inserted to be matched to the position in time of the synchronization data packet which is to be detected. Corresponding information about the position in time of a frequency correction data packet or of a following synchronization data packet can be transmitted with the FCCH-found message.

In another embodiment of the present invention, the mobile station is first switched to the observation of a first adjacent GSM base station BS2, after a successful search or on the basis of knowledge about an unsuccessful search the adjacent channel search is carried out for one or more further GSM base stations BS3, and when the adjacent channel search for a number of adjacent GSM base stations BS2, BS3 has ended successfully and/or without success, information m for influencing and/or restricting and/or ending and/or controlled continuation of the insertion of interruption phases is transmitted to the UMTS base station BS1. To this end, the initially ascertained results for the adjacent channel search can be temporarily stored using memory devices SPE in the mobile station MS.

In one embodiment of the present invention, if no adjacent channel search is successful, this is signaled, likewise using appropriate information m (FCCH/SCH-not-found), and the UMTS base station inserts no further interruption phases into the downlink data stream d at first.

In another embodiment of the present invention, the results of the adjacent channel search, for example the identity of the adjacent base station and the reception quality or field strength of the signals received from the adjacent base stations, are transmitted to the UMTS base station BS1 together with the information for influencing the insertion of interruption phases as one message, which may be split over a number of frames if appropriate.

In another embodiment of the present invention, the first base station BS1 is also a GSM base station which transmits data on the basis of a GSM standard or of a standard derived therefrom.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

A mobile station, base station and method for data transmission in a mobile radio system, wherein for the purpose of observing GSM base stations, interruption phases are inserted in a UMTS transmission. To reduce the number of these interruption phases, the maximum effective duration of the interruption phases is chosen to be shorter than is needed under optimum transmission conditions for secure detection of a data packet which is to be detected and is sent from a GSM base station. A shrewd choice of parameters provides a better ratio of effort (effective duration of the interruption phase) to result (detection probability).

In the claims:

On amended page 1, cancel line 1, and substitute the following left-hand justified heading therefor:

I Claim as My Invention:

Please cancel claims 1-18, without prejudice, and substitute the following claims therefor:

29. A method for data transmission in a mobile radio system, the method comprising the steps of:

transmitting data between a first base station and at least one mobile station based on a first transmission method;

inserting interruption phases, at least during particular transmission phases, in which the mobile station interrupts the transmission of the data and in which the mobile station is switched to reception of data packets sent by a second base station based on a second transmission method, the second base station operating on a GSM standard which is based on a synchronization frame structure having a period of 51 frames; and

inserting interruption phases having an effective total duration of a maximum of 10 observation frames.

30. A method for data transmission and a mobile radio system as claimed in claim 29, wherein a period of 52 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase.

31. A method for data transmission in a mobile radio system as claimed in claim 29, wherein a period of 26 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase.

32. A method for data transmission in a mobile radio system as claimed in claim 29, wherein a period of n_1 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase, and a period of n_2 GSM frames lies between the start of the second interruption phase and a start of a third interruption phase.

33. A method for data transmission in a mobile radio system as claimed in claim 32, wherein a period of 6 GSM frames lies between the start of the first interruption phase and the start of the second interruption phase, and a period of 46 GSM frames lies between the start of the second interruption phase and the start of the third interruption phase.

34. A method for data transmission in a mobile radio system as claimed in claim 32, wherein a period of 16 GSM frames lies between the start of the first interruption phase and the start of the second interruption phase, and a period of 36 GSM frames lies between the start of the second interruption phase and the start of the third interruption phase.

35. A method for data transmission in a mobile radio system as claimed in claim 29, the method further comprising the step of:

transmitting, via the mobile station and after reception of at least one of a characteristic data packet and a data packet to be detected from the second base station, information for influencing insertion of further interruption phases to the first base station.

36. A mobile station, comprising:
a transmitter for transmitting data from and to a first base station based on a first transmission method;

an inserting unit for inserting pauses at least during particular transmission phases in the transmission of data is interrupted; and

a switch for switching to reception of data packets sent by a second base station based on a second transmission method, the second base station operating on a GSM standard which is based on a synchronization frame structure having a period of 51 frames, wherein interruption phases having an effective total duration of a maximum of 10 observation frames are inserted.

37. A mobile station as claimed in claim 36, wherein a period of 52 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase.

38. A mobile station as claimed in claim 36, wherein a period of 52 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase.

39. A mobile station as claimed in claim 36, wherein a period of n_1 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase, and a period of n_2 GSM frames lies between the start of the second interruption phase and a start of a third interruption phase.

40. A mobile station as claimed in claim 36, further comprising:
a device for ascertaining a reception result for the data packets received from the second base station; and
a sending unit for sending to the first base station information which influences insertion of further interruption phases.

41. A base station comprising:
a transmitter for transmitting data from and to a mobile station; and
an inserting unit for inserting interruption phases at least during particular transmission phases in which the mobile station interrupts the transmission of data and in which the mobile station is switched to reception of data packets sent by a

second base station based on a second transmission method, the second base station operating on a GSM standard which is based on a synchronization frame structure having a period of 51 frames, and interruption phases having an effective total duration of a maximum of 10 observation frames are inserted.

42. A base station as claimed in claim 41, wherein a period of 52 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase.

43. A base station as claimed in claim 41, wherein a period of 26 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase.

44. A base station as claimed in claim 41, wherein a period of n_1 GSM frames lies between a start of a first interruption phase and a start of a second interruption phase, and a period of n_2 GSM frames lies between the start of the second interruption phase and a start of a third interruption phase.

45. A base station as claimed in claim 41, further comprising:
a receiver for receiving information which influences insertion of interruption phases; and
a unit for influencing insertion of interruption phases based on a reception result.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned “Version With Markings To Show Changes Made”.

In addition, the present amendment cancels original claims 1-18 in favor of new claims 29-45. Claims 29-45 have been presented solely because the revisions

by red-lining and underlining which would have been necessary in claims 1-18 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§103, 102, 103 or 112. Indeed, the cancellation of claims 1-18 does not constitute an intent on the part of the Applicant to surrender any of the subject matter of claims 1-18.

Early consideration on the merits is respectfully requested.

Respectfully submitted,



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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

S P E C I F I C A T I O N

TITLE

Method for data transmission in a mobile radio system, mobile station and base station

MOBILE STATION, BASE STATION AND METHOD FOR DATA TRANSMISSION IN A MOBILE RADIO SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a base station, a mobile station and a method for data transmission in a communication system, in particular in a CDMA mobile radio system, where the data, structured in frames, ~~are is~~ transmitted such that a mobile station is able to perform other functions; in particular, to carry out tests using a reception device, during one or more interruption phases in which it interrupts the reception (of the previous source or of the data from the base station) and/or the processing of received data or sending. “Transmission” is ~~also to be~~ understood ~~to mean as~~ sending and/or receiving below.

Description of the Prior Art

In communication systems, data (for example voice data, image data or system data) ~~are is~~ transmitted on transmission links between base stations and mobile stations. In radio communication systems, this is done using electromagnetic waves via an air or radio interface. In this context, carrier frequencies are used which are situated in the frequency band provided for the respective system. In the case of the GSM (Global System for Mobile Communication), the carrier frequencies are in the range of 900 MHz. For future radio communication systems, for example the UMTS (Universal Mobile Telecommunication System) or other third generation systems, frequencies in the frequency band of 2000 MHz are provided.

Particularly in future CDMA systems, a base station basically sends continuously, in essence, in the downlink direction, for example, that is to say in the direction from the base station to a mobile station. The data transmitted during sending ~~are~~ is usually structured in frames which each have a prescribed length. Particularly with different services such as voice data transmission and video data transmission, the frames may also have different structures and lengths. The structure and/or length of each frame in a continuous series of frames is prescribed and/or is recognized by the mobile station, however.

Particularly in cellular mobile radio systems, the mobile station occasionally also needs to perform functions other than data reception which cannot be performed at the same time, at least during the operation of only a single reception device. By way of example, from time to time the mobile station in a radio communication system of cellular design in which the base stations in various cells send on different frequencies needs to test whether it is able to receive radio signals from another base station with good reception quality. For this purpose, the mobile station sets its reception device to a frequency other than the frequency on which it currently receives data.

In order to be able to send from the base station to the mobile station without interruption, it has already been proposed that the mobile station be equipped with a second reception device. In practice, however, this solution is usually rejected for cost reasons.

Another proposal is known according to which the base station interrupts sending at prescribed times in order to allow the receiving station to carry out an adjacent channel search (search for an adjacent base station or for particular data packets transmitted by these base stations, where data packets may also may be understood below to mean be synchronization, frequency correction or pilot signal bursts) using its individual reception device.

To prevent a loss of data, the base station sends the data beforehand at a higher transmission rate than the fundamentally constant permanent transmission rate. So that this does not result in higher bit error rates (BER), the transmission power additionally needs to be increased during this time.

The frequency at which the interruption phases recur and the length of the interruption phases depend on the particular system and also on the particular operating state of the system. By way of example, interruption phases each having a length of 5 to 6 ms, respectively, are sufficient for an adjacent channel search by a mobile station in a radio communication system organized on a cellular basis. WO-A-97 25827 discloses a method for data transmission, in which interruption phases for observing an adjacent base station are inserted during transmission. However, provision is made in this case for the interruption phases to be inserted at regular intervals, which entails the disadvantage that the efficiency of the data transmission is reduced with each interruption phase.

Since the losses in transmission quality also increase with the number of interruption phases inserted, it is desirable for the smallest possible number of interruption phases to be inserted.

By way of example, a GSM frame transmitted by the GSM base station contains eight timeslots which each contain a data packet. The data packets transmitted by the GSM base station BS2, such as synchronization data packets (data packets to be detected, synchronization burst), frequency correction data packets (characteristic data packets, frequency correction burst) and normal data packets, are all subordinate to the same time frame. The GSM base stations transmit all 10 time frames (GSM frames) 4 times and, after a subsequent 11 time frames (GSM frames) (51 time frames in total), a frequency correction data packet, and one respective time frame later, a synchronization data packet.

If interruption phases based on the GSM standard were now inserted with a period of 26 time frames (GSM frames), the fact that the period of 51 time frames and the period of 26 time frames have no common denominator would cause a cyclic shift in the two time frame periods, so that after a maximum of 11 times 26 time frames, that is to say after 11 observation frames, the sought data packet which is to be detected would be received if the mobile station is not too distant from the respective adjacent base station BS2, BS3 or if no interference which is too intense arises during transmission.

It is an object of the present invention, therefore, to specify a method for data transmission, a mobile station and a base station which permit second base stations to be reliably observed while transmission quality is good.

~~The object is achieved by the independent patent claims. Developments are the subject matter of the dependent claims.~~

SUMMARY OF THE INVENTION

Accordingly, the present invention is based, in particular, on the concept of, contrary to the prior art, inserting interruption phases in which the mobile station interrupts the transmission, in particular the reception, of the data sent by the first base station and/or the processing of the received data not with a maximum effective total duration which would be needed under optimum transmission conditions for secure detection of a data packet which is to be detected, but instead inserting fewer and/or shorter interruption phases.

Complex simulations using simulation tools developed specially for this purpose have proved that, when the effective total duration of the interruption phases is shortened, contrary to the prior art, to a duration of a maximum of 9 or a maximum of 10 observation frames, the effective total duration of the interruption phases can be reduced by a much greater proportion than, in return, the theoretical detection probability for a data packet which is to be detected decreases. The effect of this is that the transmission quality from the first base station to a mobile station is improved, but in return the detection probability for a data packet which is to be detected remains comparatively high with respect thereto.

In this case, the data can be sent, by way of example, from the first base station to the mobile station, in which case, at least during particular transmission phases, interruption phases are inserted in which the first base station interrupts sending, and the mobile station interrupts the reception and/or the processing of received data, for example, ~~and in which~~ In addition, the mobile station is switched to the reception of the characteristic data packets and/or data packets which are to be detected, which are sent cyclically by a second base station, and the maximum effective total duration of the interruption phases is shorter than would be needed under optimum transmission conditions for secure detection of a data packet which is to be detected.

The data packets sent by the second base station ~~may also~~ may be data packets which are to be detected (synchronization data packets) or characteristic data packets (frequency correction data packets).

In this context, a first transmission method, used by a first base station, may be a CDMA method, and a second transmission method, used by a second base station, may be a GSM method.

Within the context of the application, GSM frame is also understood to ~~mean~~ be a frame which contains 8 time slots and has a duration of 4.6 ms.

Within the context of the application, observation frame is also understood to ~~mean~~ be a minimum time period required in order to observe a GSM frame. In this case, the exact duration of an observation frame is implementation-dependent; however, in order to ensure full detection of a GSM frame and to allow for the time needed for changing over the synthesizer frequency, it is generally longer than the duration of a GSM frame and may thus also have a duration of 9 time slots, 10 time slots (5.7 ms), 11 time slots or 12 time slots (6.9 ms).

Since many different variants are possible for inserting the interruption phases for the purpose of the adjacent channel search, the term “maximum effective total duration of the interruption phases” within the context of this application denotes the sum of all the interruption phases inserted as a maximum in order to observe an adjacent base station. However, this does not preclude further interruption phases from being inserted during subsequent repetition of the adjacent channel search, although a new effective total duration of the interruption phases is formed in this case. Under these circumstances, the individual interruption phases ~~may~~ each may have the duration of an observation frame, but ~~may also~~ may have any other duration. The duration of an interruption phase ~~may~~ also may have a multiple or a fraction of the duration of an observation frame. It is also possible for the individual interruption phases to have different durations.

In one ~~development~~ embodiment of the present invention, a period of 52 GSM frames lies between the start of a first interruption phase and the start of a second interruption phase.

Simulations have been able to show that this allows the effective total duration of the interruption phases to be reduced to 91%, with a mere loss of 2%

needing to be accepted for the detection probability in return, as well as a halving of the search speed in comparison with the GSM search speed.

In another embodiment of the present invention, a period of 6 GSM frames is inserted between the start of a first interruption phase and the start of a first interruption phase and the start of a second interruption phase, and a period of 46 GSM frames is inserted between the start of a second interruption phase and the start of a third interruption phase.

In this case, simulations have been able to show that, at GSM search speed, the maximum effective total duration of the interruption phases can be reduced by 9% for a comparatively very small detection possibility loss of 2%.

In ~~one development~~ another embodiment of the present invention, the insertion of further interruption phases is ended, restricted or continued under control before the maximum effective total duration of the interruption phases is actually reached. To this end, after reception of a data packet which is to be detected or possibly of another data packet, indicating the end of the adjacent channel search, such as a characteristic data packet, an appropriate message is transmitted from the mobile station to the first base station.

Thus, while data ~~are~~ is transmitted from a first base station to a mobile station in the downlink direction, for example, interruption phases are inserted, at least during particular send phases, in which the mobile station interrupts the reception of the data sent by the first base station and/or the processing of the received data and in which the mobile station is switched to the reception of data packets sent by a second base station. Depending on a reception result for these data packets sent by a second base station, information which influences the insertion of interruption phases is sent from the mobile station to the first base station.

In this way, it is possible for the insertion of interruption phases to be ended as soon as possible, and hence to be restricted as far as possible, as soon as sufficient information is known about the second base stations which are to be observed, and hence for the transmission quality to be improved. The effect of this is that the total duration of the interruption phases can be reduced further.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

~~The drawings are now used to describe exemplary embodiments of the invention in more detail. The invention is not limited to these exemplary embodiments, however. In the individual figures of the drawing:~~

Figure 1 shows a basic circuit diagram of a mobile radio system;
Figure 2 shows a basic circuit diagram of a mobile station; and
Figure 3 shows a schematic illustration of the insertion of interruption phases during a send phase.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a cellular mobile radio network ~~comprising~~ including, by way of example, a combination of a GSM (Global System for Mobile Communication) system with a UMTS (Universal Mobile Telecommunication System) system, which ~~comprises~~ includes a multiplicity of mobile switching centers MSC which are interlinked and set up access to a landline network PSTN/ISDN. In addition, these mobile switching centers MSC are connected to at least one respective base station controller BSC, which ~~may also~~ may be formed by a data processing system.

Each base station controller BSC is, in turn, connected to at least one base station BS. Such a base station BS is a radio station which is able to use a radio interface to set up a radio link to other radio stations, so-called mobile stations MS. Radio signals can be used to transmit information between the mobile stations MS and the base station BS associated with these mobile stations MS within radio channels situated within frequency bands. The range of the radio signals of a base station defines, in essence, a radio cell FZ.

Base stations BS and a base station controller BSC can be combined to form a base station system. In this context, the base station system BSS is also responsible for radio channel administration and allocation, data rate matching, monitoring of the radio transmission link, handover procedures and, in the case of

a CDMA system, for the allocation of the spread code sets which are to be used, and transmits the signaling information required for this to the mobile stations MS.

In the case of a duplex system, the frequency bands provided for the uplink (mobile station to base station) may be different than those provided for the downlink (base station to mobile station) in FDD (Frequency Division Duplex) systems, such as the GSM system, and, in TDD (Time Division Duplex) systems, such as the DECT (Digital Enhanced Cordless Telecommunications) system, different time intervals may be provided for the uplink and for the downlink. Within the different frequency bands, an FDMA (Frequency Division Multiple Access) method can implement a plurality number of frequency channels.

Terms and examples used within the context of this application also often refer to a GSM mobile radio system; they are in no way limited thereto, however, but rather ~~may~~ also easily ~~may~~ be easily mapped onto other, possibly future, mobile radio systems, such as CDMA systems, in particular wideband CDMA systems or TD/CDMA systems, by a person skilled in the art using the description. First base station BS1 is understood to ~~mean~~ be, in particular, a UMTS base station or a CDMA base station, second and/or third base stations BS2, BS3 are understood, in particular, to ~~mean~~ be GSM (adjacent) base stations which are to be observed, and mobile station is understood, in particular, to ~~mean~~ be a dual mode mobile station designed both for receiving/sending GSM signals and for receiving/sending UMTS signals or CDMA signals, said the dual mode mobile station also being able to be made ready for stationary operation, if appropriate.

Figure 2 shows a radio station which may be a mobile station MS, ~~comprising~~ including an operating unit MMI, a control device STE, a processing device VE, a power supply device SVE, a reception device EE and a transmission device SE.

The control device STE in essence ~~comprises~~ includes a program controlled microcontroller MC which has write and read access to memory modules SPE. The microcontroller MC controls and supervises all the fundamental elements and functions of the radio station, in essence controls the communication and signaling flow, reacts to keypad inputs by executing the corresponding control procedures and is also responsible for transferring the appliance into different operating states.

The processing device VE ~~can~~ also can be formed by a digital signal processor DSP which is likewise able to access memory modules SPE.

The volatile or nonvolatile memory modules SPE store the program data required for controlling the radio station and the communication flow, and also the signaling procedures in particular, appliance information, information entered by the user and information arising during the processing of signals.

The radio frequency part HF ~~comprises~~ includes the transmission device SE, having a modulator and an amplifier, and a reception device EE having a demodulator and likewise an amplifier.

The transmission device SE and the reception device EE are supplied with the frequency of a voltage controlled oscillator VCO using the synthesizer SYN. The voltage controlled oscillator VCO ~~can~~ also can be used to generate the system clock for clocking processor devices of the appliance.

For receiving and sending signals via the air interface of a mobile radio system, an antenna device ANT is provided.

The radio station ~~may~~ also may be a base station BS. In this case, the operating unit is replaced by a link to a mobile radio network, for example ~~by~~ means of via a base station controller BSC or a switching center MSC. In order to interchange data with a plurality number of mobile stations MS at the same time, the base station BS has an appropriate multiplicity of transmission and reception devices available.

Figure 3 shows the frame structure of a data transmission with a short delay time, in particular of voice transmission in a UMTS (Universal Mobile Telecommunication System), containing twelve individual frames 1 for data transmission within a respective multiframe. In this case, the illustration shows, in particular, a send phase in the downlink from a first base station BS1, in particular a UMTS base station BS1, to a mobile station MS, in particular a dual mode mobile station MS, designed not only for receiving UMTS data but also for receiving GSM data packets. The statements employed below are, in essence, restricted to the downlink. It goes without saying, however, that the present invention can be introduced not only to downlink transmission, but also to uplink transmission. It is within the scope of action of a person skilled in the art to

introduce the exemplary embodiments demonstrated below for the downlink to uplink transmission.

The individual frames 1 each have a transmission length T_f of 10 ms, ~~which means that wherein~~ the multiframe has a transmission length T_s of 120 ms in total. The respective fifth and sixth individual frames 1 have a common interruption phase 2 (possibly overlapping their frame boundaries 3) which has a length T_i . The length T_i is 6 ms, for example. The subsections of the first frame 4a, which starts before the interruption phase 2, and of the second frame 4b, which ends after the interruption phase 2, are of the same length or of the same size. In the case of the exemplary embodiment shown in ~~figure~~ 3, voice data ~~are~~ is being transmitted, so that a maximum delay of 10 ms, that is to say a frame length T_f , when evaluating the data received by the mobile station is acceptable. The data within a frame ~~are~~ is sorted, coded together and sent superimposed on one another. In the exemplary embodiment, the transmission rate of the first frame 4a and of the second frame 4b is increased, in each case, such that the same quantity of information which is to be sent, which is sent in uncompressed frames 1 over the frame length T_f , is sent in a time span $T_c = T_f - T_i/2$.

In this case, during the interruption phases, at least the sending of data to a particular mobile station carrying out the adjacent channel search is interrupted, while sending to other mobile stations can be continued, this being made possible by the use of a multiple access method, for example a CDMA method.

A GSM frame transmitted by the GSM base station contains eight timeslots which each contain a data packet. The data packets transmitted by the GSM base station BS2, such as synchronization data packets (data packets to be detected, synchronization burst), frequency correction data packets (characteristic data packets, frequency correction burst) and normal data packets, are all subordinate to the same time frame. The GSM base stations transmit all 10 time frames (GSM frames) 4 times and, after a subsequent 11 time frames (GSM frames) (51 time frames in total), a frequency correction data packet, and one respective time frame later, a synchronization data packet.

If interruption phases based on the GSM standard were now inserted with a period of 26 time frames (GSM frames), the fact that the period of 51 time frames

and the period of 26 time frames have no common denominator would cause a cyclic shift in the two time frame periods, so that after a maximum of 11 times 26 time frames, that is to say after 11 observation frames, the sought data packet which is to be detected would be received if the mobile station is not too distant from the respective adjacent base station BS2, BS3 or if no interference which is too intense arises during transmission.

If the maximum effective total duration of the interruption phases is now reduced, contrary to the prior art, from 11 observation frames to, by way of example, 10 or 9 observation frames when observing GSM base stations during the call phase for a mobile station MS and a UMTS base station BS1, the data transmission within the context of the call by the mobile station MS via the base station BS1 can be improved. The associated reduction in detection probability is comparatively small and is thus acceptable.

In one variant embodiment of the present invention, data packets which are to be detected are transmitted by a second base station BS2 within GSM frames, and interruption phases for adjacent channel observation are inserted into the downlink data transmission from a UMTS base station BS1 to a mobile station MS, with a period of 52 GSM frames lying between the start of a first interruption phase and a second interruption phase.

In another variant embodiment, a period of 26 GSM frames lies between the start of a first interruption phase and a second interruption phase.

In another embodiment of the present invention, a period of n_1 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of n_2 GSM frames lies between the start of a second interruption phase and a third interruption phase.

In another ~~variant~~ embodiment of the present invention, a period of 6 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of 46 GSM frames lies between the start of a second interruption phase and a third interruption phase.

In another ~~variant~~ embodiment of the present invention, a period of 16 GSM frames lies between the start of a first interruption phase and a second

interruption phase, and a period of 36 GSM frames lies between the start of a second interruption phase and a third interruption phase.

By way of example, while the mobile station MS is in the call condition or user data transmission condition with a current UMTS base station BS1, the interruption phases are inserted at particular points in time/intervals of time, between which there may be time spans of fixed or different length, into the downlink transmission, during which the reception device of the mobile station MS is switched to the reception of data packets from respective adjacent GSM base stations BS2, BS3. During the interruption phase 2, the UMTS base station thus interrupts the sending of data to the mobile station MS, and the mobile station MS interrupts the reception and/or the processing of data sent by the UMTS base station BS1. The mobile station MS uses the reception device EE to carry out an adjacent channel search by virtue of the control device STE switching the reception device EE to the reception of adjacent GSM base stations BS2 and of the data packets sent thereby, in order to receive any synchronization data packets dp which arrive, sent by adjacent GSM base stations BS2, BS3.

The aim of the adjacent channel search is also to detect a synchronization data packet which is to be detected. In one variant embodiment of the present invention, if, in one of these interruption phases, the mobile station MS receives a synchronization data packet which is to be detected, then the adjacent channel search has ended, at least for this base station BS2, and the mobile station MS sends appropriate control information m (SCH-found) to the first base station BS1, the UMTS base station, possibly via suitable signaling channels. The UMTS base station BS1 then inserts no further interruption phases into the downlink data stream d, at least at first. In this case, the effective total duration of the interruption phases is generally shorter than the maximum effective total duration of the interruption phases.

A synchronization data packet which is to be detected ~~can~~ also can be detected using the reception of a characteristic frequency correction data packet, since the known frame structure after reception of a frequency correction data packet ~~means that results in~~ the position of a synchronization data packet ~~is to be~~ known. Since, in the GSM system, the base stations BS2, BS3 transmit the

frequency correction data packets one time frame before the synchronization data packets, in one ~~variant~~ embodiment of the present invention, the mobile station MS is able not only to receive synchronization data packets but also to be switched to the reception of frequency correction data packets. In this case, the mobile station MS carries out an adjacent channel search in the interruption phases using the reception device EE, by virtue of the control device STE switching the reception device EE to the reception of adjacent GSM base stations BS2, in order to receive any synchronization data packets and frequency correction data packets which arrive, sent by adjacent GSM base stations BS2, BS3.

Within the context of this application, the concept of “the mobile station being switched to the reception of data packets which are to be detected and/or characteristic data packets” is also understood ~~to mean that as~~, after the customary analog and digital filtering, and possibly derotation, the received data packet ~~is~~ being compared (e.g., correlated) with the correlation series corresponding to the training sequence of a characteristic data packet dp and/or with the correlation series corresponding to the training sequence of a data packet dp which is to be detected, and hence data packets which are to be detected and characteristic data packets are sought at the same time or in parallel. Instead of correlation, other methods ~~may also~~ may be used if appropriate (e.g., FIR, IRR or other filters). If a data packet is received or detected with sufficient quality, or the information transported using the data packet is ascertained with sufficient quality, etc., the reception result for this data packet can be said to be positive.

In one ~~variant~~ embodiment, the mobile station MS is now able, after reception of a frequency correction data packet, to send information m to the UMTS base station BS1 (FCCH-found), which information now causes just one further interruption phase to be inserted into the sent data stream at first, in order to receive the synchronization data packet following the frequency correction data packet at a fixed distance. The knowledge about the relative positions in time of the frequency correction data packet and the synchronization data packet ~~means~~ that allows the position in time and also the duration (since the timeslot is now known) of the interruption phase which is to be inserted ~~can~~ to be matched to the position in time of the synchronization data packet which is to be detected.

Corresponding information about the position in time of a frequency correction data packet or of a following synchronization data packet can be transmitted with the FCCH-found message.

In another ~~variant~~ embodiment of the present invention, the mobile station is first switched to the observation of a first adjacent GSM base station BS2, after a successful search or on the basis of knowledge about an unsuccessful search the adjacent channel search is carried out for one or more further GSM base stations BS3, and when the adjacent channel search for a plurality number of adjacent GSM base stations BS2, BS3 has ended successfully and/or without success, information m for influencing and/or restricting and/or ending and/or controlled continuation of the insertion of interruption phases is transmitted to the UMTS base station BS1. To this end, the initially ascertained results for the adjacent channel search can be temporarily stored using memory devices SPE in the mobile station MS.

In one embodiment of the present invention, if no adjacent channel search is successful, this is signaled, likewise using appropriate information m (FCCH/SCH-not-found), and the UMTS base station inserts no further interruption phases into the downlink data stream d at first.

In ~~one development~~ another embodiment of the present invention, the results of the adjacent channel search, for example the identity of the adjacent base station and the reception quality or field strength of the signals received from the adjacent base stations, are transmitted to the UMTS base station BS1 together with the information for influencing the insertion of interruption phases as one message, which may be split over a plurality number of frames if appropriate.

In another ~~variant~~ embodiment of the present invention, the first base station BS1 is also a GSM base station which transmits data on the basis of a GSM standard or of a standard derived therefrom.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

Abstract

ABSTRACT OF THE DISCLOSURE

~~Method for data transmission in a mobile radio system, mobile station and base station~~

For A mobile station, base station and method for data transmission in a mobile radio system, wherein for the purpose of observing GSM base stations, interruption phases are inserted in a UMTS transmission. To reduce the number of these interruption phases, the maximum effective duration of the interruption phases is chosen to be shorter than is needed under optimum transmission conditions for secure detection of a data packet which is to be detected and is sent from a GSM base station. A shrewd choice of parameters provides a better ratio of effort (effective duration of the interruption phase) to result (detection probability).

Figure 1

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Description

Method for data transmission in a mobile radio system, mobile station and base station

5

The invention relates to a base station, a mobile station and a method for data transmission in a communication system, in particular in a CDMA mobile radio system, where the data, structured in frames, are 10 transmitted such that a mobile station is able to perform other functions, in particular to carry out tests using a reception device, during one or more interruption phases in which it interrupts the reception (of the previous source or of the data from 15 the base station) and/or the processing of received data or sending. "Transmission" is also understood to mean sending and/or receiving below.

In communication systems, data (for example voice data, image data or system data) are transmitted 20 on transmission links between base stations and mobile stations. In radio communication systems, this is done using electromagnetic waves via an air or radio interface. In this context, carrier frequencies are used which are situated in the frequency band provided 25 for the respective system. In the case of the GSM (Global System for Mobile Communication), the carrier frequencies are in the range of 900 MHz. For future radio communication systems, for example the UMTS (Universal Mobile Telecommunication System) or other 30 third generation systems, frequencies in the frequency band of 2000 MHz are provided.

Particularly in future CDMA systems, a base station sends continuously, in essence, in the downlink direction, for example, that is to say in the direction 35 from the base station to a mobile station. The data transmitted during sending are usually structured in frames which

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each have a prescribed length. Particularly with different services such as voice data transmission and video data transmission, the frames may also have different structures and lengths. The structure and/or 5 length of each frame in a continuous series of frames is prescribed and/or is recognized by the mobile station, however.

Particularly in cellular mobile radio systems, the mobile station occasionally also needs to perform 10 functions other than data reception which cannot be performed at the same time, at least during the operation of only a single reception device. By way of example, from time to time the mobile station in a radio communication system of cellular design in which 15 the base stations in various cells send on different frequencies needs to test whether it is able to receive radio signals from another base station with good reception quality. For this purpose, the mobile station sets its reception device to a frequency other than the 20 frequency on which it currently receives data.

In order to be able to send from the base station to the mobile station without interruption, it has already been proposed that the mobile station be equipped with a second reception device. In practice, 25 however, this solution is usually rejected for cost reasons.

Another proposal is known according to which the base station interrupts sending at prescribed times in order to allow the receiving station to carry out an 30 adjacent channel search (search for an adjacent base station or for particular data packets transmitted by these base stations, where data packets may also be understood below to mean synchronization, frequency correction or pilot signal bursts) using its individual reception device.

Foreign version

To prevent a loss of data, the base station sends the data beforehand at a higher transmission rate than the

- 3 -

fundamentally constant permanent transmission rate. So that this does not result in higher bit error rates (BER), the transmission power additionally needs to be increased during this time.

5 The frequency at which the interruption phases recur and the length of the interruption phases depend on the particular system and also on the particular operating state of the system. By way of example, interruption phases each having a length of 5 to 6 ms, 10 respectively, are sufficient for an adjacent channel search by a mobile station in a radio communication system organized on a cellular basis. WO-A-97 25827 discloses a method for data transmission, in which interruption phases for observing an adjacent base 15 station are inserted during transmission. However, provision is made in this case for the interruption phases to be inserted at regular intervals, which entails the disadvantage that the efficiency of the data transmission is reduced with each interruption 20 phase.

Since the losses in transmission quality also increase with the number of interruption phases inserted, it is desirable for the smallest possible number of interruption phases to be inserted.

25 By way of example, a GSM frame transmitted by the GSM base station contains eight timeslots which each contain a data packet. The data packets transmitted by the GSM base station BS2, such as synchronization data packets (data packets to be 30 detected, synchronization burst), frequency correction data packets (characteristic data packets, frequency correction burst) and normal data packets, are all subordinate to the same time frame. The GSM base stations transmit all 10 time frames (GSM frames) 4 35 times and, after a subsequent 11 time frames (GSM frames) (51 time frames in total), a frequency

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- 3a -

correction data packet, and one respective time frame later, a synchronization data packet.

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If interruption phases based on the GSM standard were now inserted with a period of 26 time frames (GSM frames), the fact that the period of 51 time frames and the period of 26 time frames have no common denominator would cause a cyclic shift in the two time frame periods, so that after a maximum of 11 times 26 time frames, that is to say after 11 observation frames, the sought data packet which is to be detected would be received if the mobile station is not too distant from the respective adjacent base station BS2, BS3 or if no interference which is too intense arises during transmission.

It is an object of the present invention to specify a method for data transmission, a mobile station and a base station which permit second base stations to be reliably observed while transmission quality is good.

The object is achieved by the independent patent claims. Developments are the subject matter of the dependent claims.

Accordingly, the invention is based, in particular, on the concept of, contrary to the prior art, inserting interruption phases in which the mobile station interrupts the transmission, in particular the reception, of the data sent by the first base station and/or the processing of the received data not with a maximum effective total duration which would be needed under optimum transmission conditions for secure detection of a data packet which is to be detected, but instead inserting fewer and/or shorter interruption phases.

Complex simulations using simulation tools developed specially for this purpose have proved that, when the effective total duration of the interruption phases is shortened, contrary to the prior art, to a duration of a maximum of 9 or a maximum of 10

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- 4a -

observation frames, the effective total duration of the interruption phases can be reduced

- 5 -

by a much greater proportion than, in return, the theoretical detection probability for a data packet which is to be detected decreases. The effect of this is that the transmission quality from the first base 5 station to a mobile station is improved, but in return the detection probability for a data packet which is to be detected remains comparatively high with respect thereto.

In this case, the data can be sent, by way of 10 example, from the first base station to the mobile station, in which case, at least during particular transmission phases, interruption phases are inserted in which the first base station interrupts sending, and the mobile station interrupts the reception and/or the 15 processing of received data, for example, and in which the mobile station is switched to the reception of the characteristic data packets and/or data packets which are to be detected, which are sent cyclically by a second base station, and the maximum effective total 20 duration of the interruption phases is shorter than would be needed under optimum transmission conditions for secure detection of a data packet which is to be detected.

The data packets sent by the second base 25 station may also be data packets which are to be detected (synchronization data packets) or characteristic data packets (frequency correction data packets).

In this context, a first transmission method, 30 used by a first base station, may be a CDMA method, and a second transmission method, used by a second base station, may be a GSM method.

Within the context of the application, GSM 35 frame is also understood to mean a frame which contains 8 time slots and has a duration of 4.6 ms.

- 5a -

Within the context of the application, observation frame is also understood to mean a minimum time period required in order to observe a GSM frame. In this case, the exact duration of an observation 5 frame is implementation-dependent; however, in order to ensure full detection of a GSM frame and to allow for the time needed for changing over the synthesizer frequency, it is generally longer than the duration of a GSM frame and may thus also have a duration of 9 time 10 slots, 10 time slots (5.7 ms), 11 time slots or 12 time slots (6.9 ms).

Since many different variants are possible for inserting the interruption phases for the purpose of the adjacent channel search, the term "maximum 15 effective total duration of the interruption phases" within the context of this application denotes the sum of all the interruption phases inserted as a maximum in order to observe an adjacent base station. However, this does not preclude further interruption phases from 20 being inserted during subsequent repetition of the adjacent channel search, although a new effective total duration of the interruption phases is formed in this case. Under these circumstances, the individual interruption phases may each have the duration of an 25 observation frame, but may also have any other duration. The duration of an interruption phase may also have a multiple or a fraction of the duration of an observation frame. It is also possible for the individual interruption phases to have different 30 durations.

In one development of the invention, a period of 52 GSM frames lies between the start of a first interruption phase and the start of a second interruption phase.

35 Simulations have been able to show that this allows the effective total duration of the

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- 5b -

interruption phases to be reduced to 91%, with a mere loss of 2% needing to be accepted for the detection probability in return, as well as a halving of the search speed in comparison with the GSM search speed.

5 In another embodiment of the invention, a period of 6 GSM frames is inserted between the start of a first interruption phase and the start of a second interruption phase, and a period of 46 GSM frames is

Foreign version

inserted between the start of a second interruption phase and the start of a third interruption phase.

In this case, simulations have been able to show that, at GSM search speed, the maximum effective 5 total duration of the interruption phases can be reduced by 9% for a comparatively very small detection possibility loss of 2%.

In one development of the invention, the insertion of further interruption phases is ended, 10 restricted or continued under control before the maximum effective total duration of the interruption phases is actually reached. To this end, after reception of a data packet which is to be detected or possibly of another data packet, indicating the end of 15 the adjacent channel search, such as a characteristic data packet, an appropriate message is transmitted from the mobile station to the first base station.

Thus, while data are transmitted from a first base station to a mobile station in the downlink 20 direction, for example, interruption phases are inserted, at least during particular send phases, in which the mobile station interrupts the reception of the data sent by the first base station and/or the processing of the received data and in which the mobile 25 station is switched to the reception of data packets sent by a second base station. Depending on a reception result for these data packets sent by a second base station, information which influences the insertion of interruption phases is sent from the mobile station to 30 the first base station.

In this way, it is possible for the insertion of interruption phases to be ended as soon as possible, and hence to be restricted as far as possible, as soon as sufficient information is known about the second 35 base stations which are to be observed, and hence for the transmission

Foreign version

quality to be improved. The effect of this is that the total duration of the interruption phases can be reduced further.

5 The drawings are now used to describe exemplary embodiments of the invention in more detail. The invention is not limited to these exemplary embodiments, however. In the individual figures of the drawing:

10 Figure 1 shows a basic circuit diagram of a mobile radio system;

Figure 2 shows a basic circuit diagram of a mobile station;

15 Figure 3 shows a schematic illustration of the insertion of interruption phases during a send phase.

Figure 1 shows a cellular mobile radio network comprising, by way of example, a combination of a GSM (Global System for Mobile Communication) system with a UMTS (Universal Mobile Telecommunication System) 20 system, which comprises a multiplicity of mobile switching centers MSC which are interlinked and set up access to a landline network PSTN/ISDN. In addition, these mobile switching centers MSC are connected to at least one respective base station controller BSC, which 25 may also be formed by a data processing system.

Each base station controller BSC is in turn connected to at least one base station BS. Such a base station BS is a radio station which is able to use a radio interface to set up a radio link to other radio 30 stations, so-called mobile stations MS. Radio signals can be used to transmit information between the mobile stations MS and the base station BS associated with these mobile stations MS within radio channels situated within frequency bands. The range of the radio signals 35 of a base station defines, in essence, a radio cell FZ.

Foreign version

Base stations BS and a base station controller BSC can be combined to form a base station system. In this context, the base station system BSS is also responsible for radio channel administration and allocation, data rate matching, monitoring of the radio transmission link, handover procedures and, in the case of a CDMA system, for the allocation of the spread code sets which are to be used, and transmits the signaling information required for this to the mobile stations 10 MS.

In the case of a duplex system, the frequency bands provided for the uplink (mobile station to base station) may be different than those provided for the downlink (base station to mobile station) in FDD (Frequency Division Duplex) systems, such as the GSM system, and, in TDD (Time Division Duplex) systems, such as the DECT (Digital Enhanced Cordless Telecommunications) system, different time intervals may be provided for the uplink and for the downlink. 20 Within the different frequency bands, an FDMA (Frequency Division Multiple Access) method can implement a plurality of frequency channels.

Terms and examples used within the context of this application also often refer to a GSM mobile radio system; they are in no way limited thereto, however, but rather may also easily be mapped onto other, possibly future, mobile radio systems, such as CDMA systems, in particular wideband CDMA systems or TD/CDMA systems, by a person skilled in the art using the 30 description. First base station BS1 is understood to mean, in particular, a UMTS base station or a CDMA base station, second and/or third base stations BS2, BS3 are understood, in particular, to mean GSM (adjacent) base stations which are to be observed, and mobile station 35 is understood, in particular, to mean a dual mode mobile station designed both for

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receiving/sending GSM signals and for receiving/sending
UMTS signals or CDMA signals, said

Foreign version

dual mode mobile station also being able to be made ready for stationary operation, if appropriate.

Figure 2 shows a radio station which may be a mobile station MS, comprising an operating unit MMI, a 5 control device STE, a processing device VE, a power supply device SVE, a reception device EE and a transmission device SE.

The control device STE in essence comprises a program controlled microcontroller MC which has write 10 and read access to memory modules SPE. The microcontroller MC controls and supervises all the fundamental elements and functions of the radio station, in essence controls the communication and signaling flow, reacts to keypad inputs by executing 15 the corresponding control procedures and is also responsible for transferring the appliance into different operating states.

The processing device VE can also be formed by a digital signal processor DSP which is likewise able 20 to access memory modules SPE.

The volatile or nonvolatile memory modules SPE store the program data required for controlling the radio station and the communication flow, and also the signaling procedures in particular, appliance 25 information, information entered by the user and information arising during the processing of signals.

The radiofrequency part HF comprises the transmission device SE, having a modulator and an amplifier, and a reception device EE having a 30 demodulator and likewise an amplifier.

The transmission device SE and the reception device EE are supplied with the frequency of a voltage controlled oscillator VCO

Foreign version

using the synthesizer SYN. The voltage controlled oscillator VCO can also be used to generate the system clock for clocking processor devices of the appliance.

For receiving and sending signals via the air 5 interface of a mobile radio system, an antenna device ANT is provided.

The radio station may also be a base station 10 BS. In this case, the operating unit is replaced by a link to a mobile radio network, for example by means of a base station controller BSC or a switching center MSC. In order to interchange data with a plurality of mobile stations MS at the same time, the base station BS has an appropriate multiplicity of transmission and reception devices available.

15 Figure 3 shows the frame structure of a data transmission with a short delay time, in particular of voice transmission in a UMTS (Universal Mobile Telecommunication System), containing twelve individual frames 1 for data transmission within a respective 20 multiframe. In this case, the illustration shows, in particular, a send phase in the downlink from a first base station BS1, in particular a UMTS base station BS1, to a mobile station MS, in particular a dual mode mobile station MS, designed not only for receiving UMTS 25 data but also for receiving GSM data packets. The statements employed below are, in essence, restricted to the downlink. It goes without saying, however, that the invention can be introduced not only to downlink transmission, but also to uplink transmission. It is 30 within the scope of action of a person skilled in the art to introduce the exemplary embodiments demonstrated below for the downlink to uplink transmission.

The individual frames 1 each have a transmission length T_f of 10 ms, which means that the multiframe has a transmission length T_s of 120 ms in 35 total. The respective fifth and sixth individual

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frames 1 have a common interruption phase 2 (possibly overlapping their frame boundaries 3) which has a length T_i . The length T_i is 6 ms, for example. The subsections of the first frame 4a, which starts before 5 the interruption phase 2, and of the second frame 4b, which ends after the interruption phase 2, are of the same length or of the same size. In the case of the exemplary embodiment shown in figure 3, voice data are being transmitted, so that a maximum delay of 10 ms, 10 that is to say a frame length T_f , when evaluating the data received by the mobile station is acceptable. The data within a frame are sorted, coded together and sent superimposed on one another. In the exemplary embodiment, the transmission rate of the first frame 4a 15 and of the second frame 4b is increased in each case such that the same quantity of information which is to be sent, which is sent in uncompressed frames 1 over the frame length T_f , is sent in a time span $T_c = T_f - T_i/2$.

20 In this case, during the interruption phases, at least the sending of data to a particular mobile station carrying out the adjacent channel search is interrupted, while sending to other mobile stations can be continued, this being made possible by the use of a 25 multiple access method, for example a CDMA method.

A GSM frame transmitted by the GSM base station contains eight timeslots which each contain a data packet. The data packets transmitted by the GSM base station BS2, such as synchronization data packets (data 30 packets to be detected, synchronization burst), frequency correction data packets (characteristic data packets, frequency correction burst) and normal data packets, are all subordinate to the same time frame. The GSM base stations transmit all 10 time frames (GSM 35 frames) 4 times and, after a subsequent 11 time frames (GSM frames) (51 time frames in total), a frequency correction

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data packet, and one respective time frame later, a synchronization data packet.

If interruption phases based on the GSM standard were now inserted with a period of 26 time frames (GSM frames), the fact that the period of 51 time frames and the period of 26 time frames have no common denominator would cause a cyclic shift in the two time frame periods, so that after a maximum of 11 times 26 time frames, that is to say after 11 observation frames, the sought data packet which is to be detected would be received if the mobile station is not too distant from the respective adjacent base station BS2, BS3 or if no interference which is too intense arises during transmission.

If the maximum effective total duration of the interruption phases is now reduced, contrary to the prior art, from 11 observation frames to, by way of example, 10 or 9 observation frames when observing GSM base stations during the call phase for a mobile station MS and a UMTS base station BS1, the data transmission within the context of the call by the mobile station MS via the base station BS1 can be improved. The associated reduction in detection probability is comparatively small and is thus acceptable.

In one variant embodiment of the invention, data packets which are to be detected are transmitted by a second base station BS2 within GSM frames, and interruption phases for adjacent channel observation are inserted into the downlink data transmission from a UMTS base station BS1 to a mobile station MS, with a period of 52 GSM frames lying between the start of a first interruption phase and a second interruption phase.

Foreign version

In another variant embodiment, a period of 26 GSM frames lies between the start of a first interruption phase and a second interruption phase.

5 In another embodiment of the invention, a period of n_1 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of n_2 GSM frames lies between the start of a second interruption phase and a third interruption phase.

10 In another variant embodiment of the invention, a period of 6 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of 46 GSM frames lies between the start of a second interruption phase and a third 15 interruption phase.

15 In another variant embodiment of the invention, a period of 16 GSM frames lies between the start of a first interruption phase and a second interruption phase, and a period of 36 GSM frames lies between the 20 start of a second interruption phase and a third interruption phase.

20 By way of example, while the mobile station MS is in the call condition or user data transmission condition with a current UMTS base station BS1, the 25 interruption phases are inserted at particular points in time/intervals of time, between which there may be time spans of fixed or different length, into the downlink transmission, during which the reception device of the mobile station MS is switched to the 30 reception of data packets from respective adjacent GSM base stations BS2, BS3. During the interruption phase 2, the UMTS base station thus interrupts the sending of data to the mobile station MS, and the mobile station MS interrupts the reception and/or the processing of 35 data sent by the

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UMTS base station BS1. The mobile station MS uses the reception device EE to carry out an adjacent channel search by virtue of the control device STE switching the reception device EE to the reception of adjacent 5 GSM base stations BS2 and of the data packets sent thereby, in order to receive any synchronization data packets dp which arrive, sent by adjacent GSM base stations BS2, BS3.

The aim of the adjacent channel search is also 10 to detect a synchronization data packet which is to be detected. In one variant embodiment of the invention, if, in one of these interruption phases, the mobile station MS receives a synchronization data packet which is to be detected, then the adjacent channel search has 15 ended, at least for this base station BS2, and the mobile station MS sends appropriate control information m (SCH-found) to the first base station BS1, the UMTS base station, possibly via suitable signaling channels. The UMTS base station BS1 then inserts no further 20 interruption phases into the downlink data stream d, at least at first. In this case, the effective total duration of the interruption phases is generally shorter than the maximum effective total duration of the interruption phases.

25 A synchronization data packet which is to be detected can also be detected using the reception of a characteristic frequency correction data packet, since the known frame structure after reception of a frequency correction data packet means that the 30 position of a synchronization data packet is known. Since, in the GSM system, the base stations BS2, BS3 transmit the frequency correction data packets one time frame before the synchronization data packets, in one variant embodiment of the invention, the mobile station 35 MS is able not only to receive synchronization data packets but also to be switched to the reception of frequency correction data packets. In this case, the

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mobile station MS carries out an adjacent channel search in the interruption phases using

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the reception device EE, by virtue of the control device STE switching the reception device EE to the reception of adjacent GSM base stations BS2, in order to receive any synchronization data packets and 5 frequency correction data packets which arrive, sent by adjacent GSM base stations BS2, BS3.

Within the context of this application, the concept of "the mobile station being switched to the reception of data packets which are to be detected 10 and/or characteristic data packets" is also understood to mean that, after the customary analog and digital filtering, and possibly derotation, the received data packet is compared (e.g. correlated) with the correlation series corresponding to the training 15 sequence of a characteristic data packet dp and/or with the correlation series corresponding to the training sequence of a data packet dp which is to be detected, and hence data packets which are to be detected and characteristic data packets are sought at the same time 20 or in parallel. Instead of correlation, other methods may also be used if appropriate (e.g. FIR, IRR or other filters). If a data packet is received or detected with sufficient quality, or the information transported using the data packet is ascertained with sufficient 25 quality etc., the reception result for this data packet can be said to be positive.

In one variant embodiment, the mobile station MS is now able, after reception of a frequency correction data packet, to send information m to the 30 UMTS base station BS1 (FCCH-found), which information now causes just one further interruption phase to be inserted into the sent data stream at first, in order to receive the synchronization data packet following the frequency correction data packet at a fixed 35 distance. The knowledge about the relative positions in time of the frequency correction data packet and the synchronization data packet means that the position in

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time and also the duration (since the timeslot is now known) of the interruption phase which is to be inserted can be matched to the position in time of the synchronization data packet which is to be

detected. Corresponding information about the position in time of a frequency correction data packet or of a following synchronization data packet can be transmitted with the FCCH-found message.

5 In another variant embodiment of the invention, the mobile station is first switched to the observation of a first adjacent GSM base station BS2, after a successful search or on the basis of knowledge about an unsuccessful search the adjacent channel search is
10 carried out for one or more further GSM base stations BS3, and when the adjacent channel search for a plurality of adjacent GSM base stations BS2, BS3 has ended successfully and/or without success, information m for influencing and/or restricting and/or ending
15 and/or controlled continuation of the insertion of interruption phases is transmitted to the UMTS base station BS1. To this end, the initially ascertained results for the adjacent channel search can be temporarily stored using memory devices SPE in the
20 mobile station MS.

 In one embodiment of the invention, if no adjacent channel search is successful, this is signaled, likewise using appropriate information m (FCCH/SCH-not-found), and the UMTS base station inserts no further interruption phases into the downlink data stream d at first.

 In one development of the invention, the results of the adjacent channel search, for example the identity of the adjacent base station and the reception quality or field strength of the signals received from the adjacent base stations, are transmitted to the UMTS base station BS1 together with the information for influencing the insertion of interruption phases as one message, which may be split over a plurality of frames
35 if appropriate.

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In another variant embodiment of the invention, the first base station BS1 is also a GSM base station which transmits data on the basis of a GSM standard or of a standard derived therefrom.

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Patent claims

1. A method for data transmission in a mobile radio system, in which

5 - data (d) are transmitted between a first base station (BS1) and at least one mobile station (MS) on the basis of a first transmission method,

10 - at least during particular transmission phases, interruption phases (2) are inserted in which the mobile station (MS) interrupts the transmission of data (d) and in which the mobile station (MS) is switched to the reception of data packets (dp) sent by a second base station (BS2) on the basis of a second transmission method, where the second base station 15 (BS2) operates on the basis of the GSM standard or of a standard derived therefrom which is likewise based on a synchronization frame structure having a period of 51 frames, and

20 - interruption phases having an effective total duration of a maximum of 9 or of a maximum of 10 observation frames are inserted.

2. The method as claimed in claim 1, in which

25 - a period of 52 GSM frames lies between the start of a first interruption phase and a second interruption phase.

4. The method as claimed in claim 1, in which

- a period of 26 GSM frames lies between the start of a first interruption phase and a second interruption phase.

30 5. The method as claimed in claim 1, in which

- a period of n1 GSM frames lies between the start of a first interruption phase and a second interruption phase, and

- a period of n_2 GSM frames lies between the start of a second interruption phase and a third interruption phase.

6. The method as claimed in claim 5, in which

5 - a period of 6 GSM frames lies between the start of a first interruption phase and a second interruption phase, and

10 - a period of 46 GSM frames lies between the start of a second interruption phase and a third interruption phase.

7. The method as claimed in claim 5, in which

15 - a period of 16 GSM frames lies between the start of a first interruption phase and a second interruption phase, and

16 - a period of 36 GSM frames lies between the start of a second interruption phase and a third interruption phase.

8. The method as claimed in one of the preceding claims, in which,

20 after reception of a characteristic data packet and/or of a data packet which is to be detected from a second base station (BS2), the mobile station (MS) transmits information for influencing the insertion of further interruption phases to the first base station (BS1).

25 9. A mobile station (MS) having

- means (EE, SE) for transmitting data from and to a first base station (BS1) on the basis of a first transmission method,

30 - means (STE) for inserting pauses at least during particular transmission phases in which the transmission of data is interrupted,

- means (STE) for switching to the reception of data packets sent by a second base station (BS2) on the basis of a

second transmission method, where the second base station (BS2) operates on the basis of the GSM standard or of a standard derived therefrom which is likewise based on a synchronization frame structure having a period of 51 frames, where interruption phases having an effective total duration of a maximum of 9 or a maximum of 10 observation frames are inserted.

10. The mobile station (MS) as claimed in claim 9, in which

10 a period of 52 GSM frames lies between the start of a first interruption phase and a second interruption phase.

11. The mobile station (MS) as claimed in claim 9, in which

15 a period of 52 GSM frames lies between the start of a first interruption phase and a second interruption phase.

12. The mobile station (MS) as claimed in claim 9, in which

20 - a period of n1 GSM frames lies between the start of a first interruption phase and a second interruption phase, and

25 - a period of n2 GSM frames lies between the start of a second interruption phase and a third interruption phase.

13. The mobile station (MS) as claimed in one of claims 9 to 12, having

30 - means for ascertaining a reception result for the data packets received from a second base station, and

- means (SE) for sending to the first base station information which influences the insertion of further interruption phases.

14. A base station (BS1) having

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- means for transmitting data from and to a mobile station (MS),

5 - means for inserting interruption phases at least during particular transmission phases (2) in which the mobile station (MS) interrupts the transmission of data (d) and in which the mobile station (MS) is switched to the reception of data packets (dp) sent by a second base station (BS2) on the basis of a second transmission method, where the second base station (BS2) operates on the basis of the GSM standard or of a standard derived therefrom which is 10 likewise based on a synchronization frame structure having a period of 51 frames, and interruption phases having an effective total duration of a maximum of 9 or a maximum of 10 observation frames are inserted.

15. 15. The base station (BS1) as claimed in claim 14, in which

- a period of 52 GSM frames lies between the start of a first interruption phase and a second interruption phase.

16. 16. The base station (BS1) as claimed in claim 14, in which

a period of 26 GSM frames lies between the start of a first interruption phase and a second interruption phase.

17. 17. The base station (BS1) as claimed in claim 14, in which

- a period of n_1 GSM frames lies between the start of a first interruption phase and a second interruption phase, and

30 - a period of n_2 GSM frames lies between the start of a second interruption phase and a third interruption phase.

18. 18. The base station (BS1) as claimed in one of claims 14 to 17, having

35 - means for receiving information which influences the insertion of interruption phases, and

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- means for influencing the insertion of interruption phases on the basis of the reception result.

Abstract

Method for data transmission in a mobile radio system, mobile station and base station

For the purpose of observing GSM base stations, interruption phases are inserted in a UMTS transmission. To reduce the number of these interruption phases, the maximum effective duration of the interruption phases is chosen to be shorter than is needed under optimum transmission conditions for secure detection of a data packet which is to be detected and is sent from a GSM base station. A shrewd choice of parameters provides a better ratio of effort (effective duration of the interruption phase) to result (detection probability).

Figure 1

FIG 1

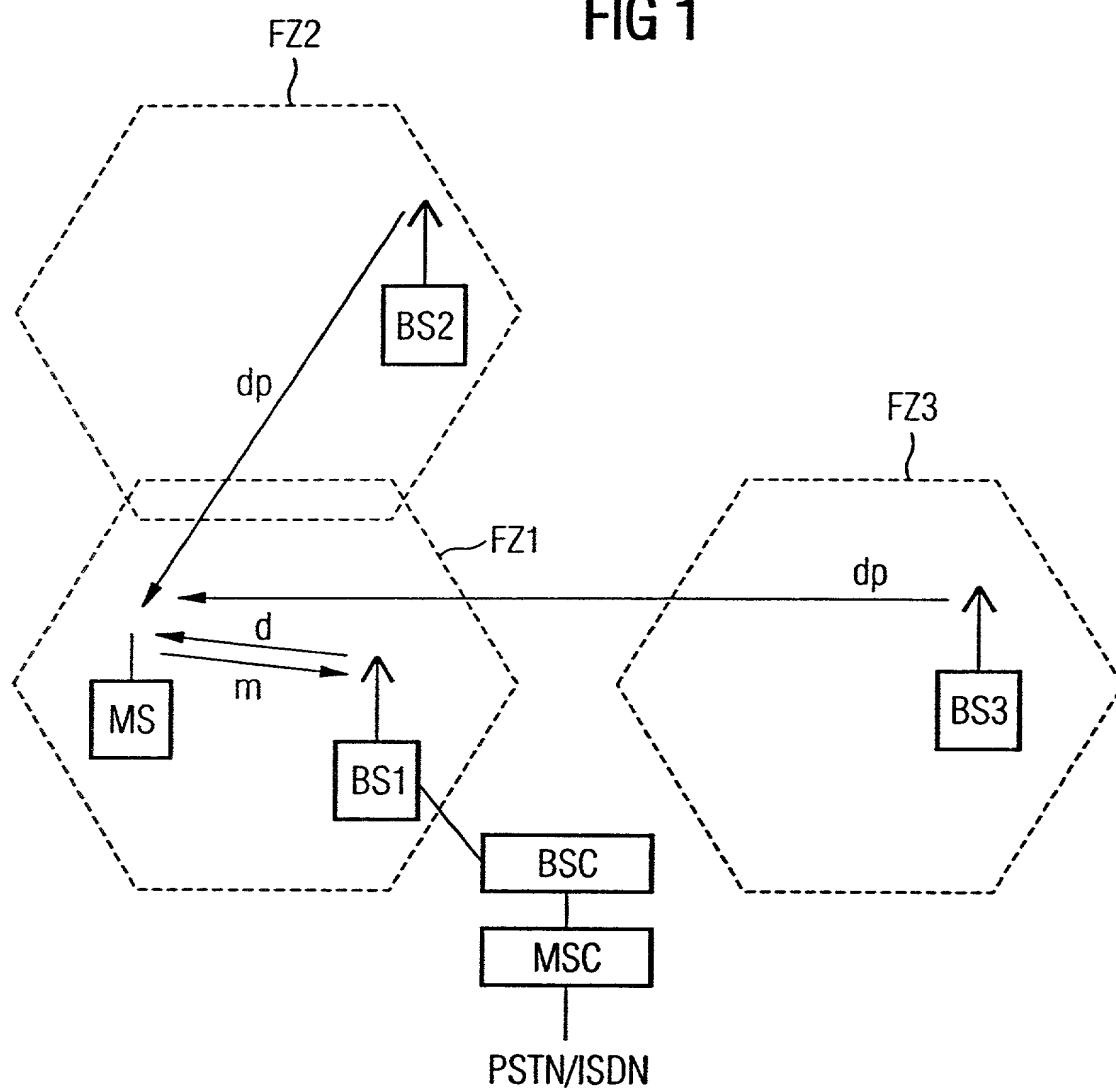


FIG 2

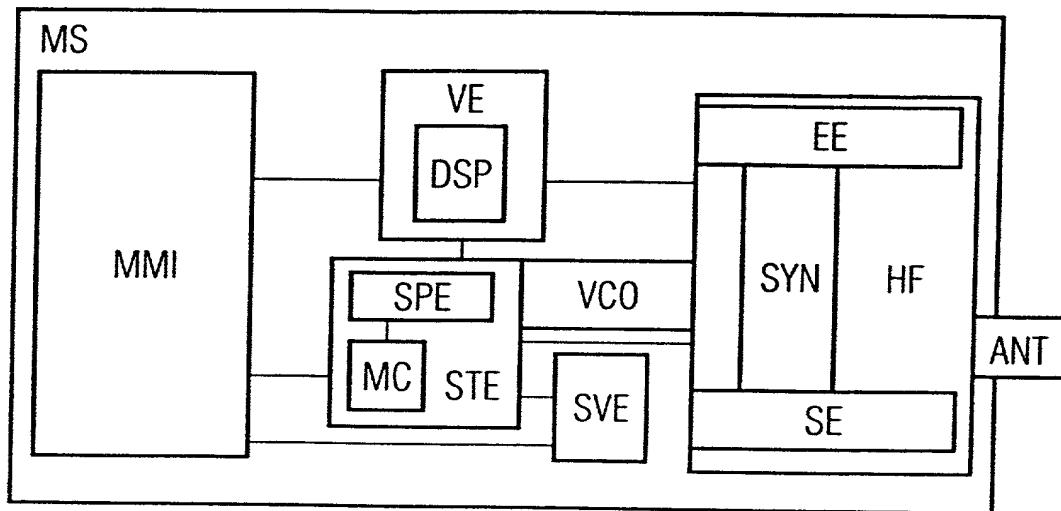
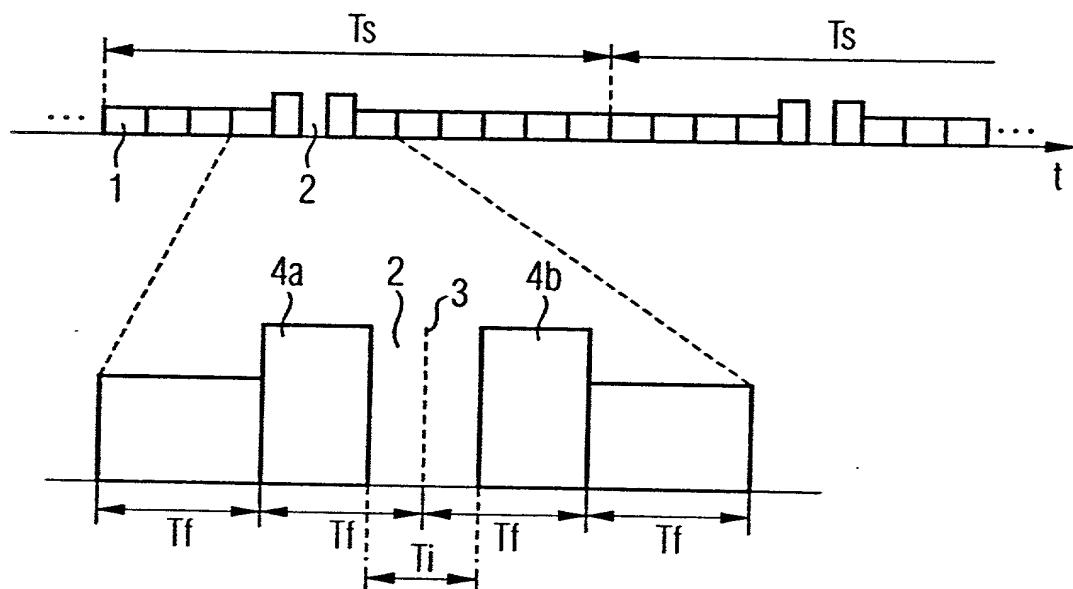


FIG 3



Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Verfahren zur Optimierung der zur Nachbarkanalüberwachung nötigen Unterbrechungspausen

deren Beschreibung

(zutreffendes ankreuzen)

hier beigelegt ist.

am 02.11.1999 als

PCT internationale Anmeldung

PCT Anmeldungsnummer PCT/DE99/03484

eingereicht wurde und am _____

abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmelde datum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method for optimizing interruption phases required for adjacent channel monitoring

the specification of which

(check one)

is attached hereto.

was filed on 02.11.1999 as

PCT international application

PCT Application No. PCT/DE99/03484

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

<u>19850866.2</u> (Number) (Nummer)	<u>DE</u> (Country) (Land)	<u>04.11.1998</u> (Day Month Year Filed) (Tag Monat Jahr eingereicht)	<input checked="" type="checkbox"/> Yes Ja	<input type="checkbox"/> No Nein
<u>19851600.2</u> (Number) (Nummer)	<u>DE</u> (Country) (Land)	<u>09.11.1998</u> (Day Month Year Filed) (Tag Monat Jahr eingereicht)	<input checked="" type="checkbox"/> Yes Ja	<input type="checkbox"/> No Nein
			<input type="checkbox"/> Yes Ja	<input type="checkbox"/> No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

<u>PCT/DE99/03484</u> (Application Serial No.) (Anmeldeseriennummer)	<u>02.11.1999</u> (Filing Date D, M, Y) (Anmeldedatum T, M, J)	<u>(Status)</u> (patentiert, anhangig, aufgegeben)	<u>(Status)</u> (patented, pending, abandoned)
<u>(Application Serial No.)</u> (Anmeldeseriennummer)	<u>(Filing Date D, M, Y)</u> (Anmeldedatum T, M, J)	<u>(Status)</u> (patentiert, anhangig, aufgegeben)	<u>(Status)</u> (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozeßordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und dass derart wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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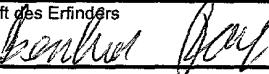
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Voller Name des einzigen oder ursprünglichen Erfinders. BERNHARD RAAF	Full name of sole or first inventor: BERNHARD RAAF		
Unterschrift des Erfinders 	Datum 06.04.07	Inventor's signature	Date
Wohnsitz MUENCHEN, DEUTSCHLAND	Residence MUENCHEN, GERMANY 		
Staatsangehörigkeit DE	Citizenship DE		
Postanschrift MAXHOFSTR. 62	Post Office Address MAXHOFSTR. 62		
81475 MUENCHEN	81475 MUENCHEN		
Voller Name des zweiten Miterfinders (falls zutreffend):		Full name of second joint inventor, if any:	
Unterschrift des Erfinders	Datum	Second Inventor's signature	Date
Wohnsitz ,	Residence ,		
Staatsangehörigkeit	Citizenship		
Postanschrift	Post Office Address		

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).